

TITLE

**WIRE/WIRELESS UNIFIED IN-BUILDING COMMUNICATION
METHOD AND SYSTEM**

CLAIM OF PRIORITY

[0001] This application claims priority to an application entitled "Wire/Wireless Unified In-Building Communication Method and System" filed in the Korean Industrial Property Office on May 24, 2000 and assigned Serial No. 2000-28087, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Technical Field

[0002] The present invention relates generally to a unified communication system, and in particular, to a system which can provide both wire and wireless unified in-building communication services, and method of providing both wire and wireless unified in-building communication services.

Related Art

[0003] The invention premises that a communication service area is limited to one building or a prescribed local area.

[0004] A wire in-building communication system can use a private branch exchange (PBX) or

1 a keyphone system for a voice service, and can use a local area network (LAN) switch and a
2 router, associated with a server, for a data service. In a wireless in-building communication
3 technology, there can be introduced a cordless telephone-second generation (CT-2) technology
4 and a European global system for mobile (GSM) communication technology.

5 [0005] Exemplars of recent efforts in the communications arts include U.S. Patent No.
6 5,537,610 to Mauger *et al.*, entitled *MOBILE COMMUNICATION HAVING MOBILE*
7 *SUBSCRIBERS, PCN NETWORK, PBX AND A LOCAL EXCHANGE*, issued on July 16, 1996,
8 U.S. Patent No. 5,303,287 to Laborde, entitled *INTEGRATED PERSONAL/CELLULAR*
9 *COMMUNICATIONS SYSTEM ARCHITECTURE*, issued on April 12, 1994, U.S. Patent No.
10 6,073,029 to Smith *et al.*, entitled *METHOD AND SYSTEM FOR PROVIDING WIRELESS*
11 *COMMUNICATIONS TO A SUBSCRIBER OF A PRIVATE WIRELINE NETWORK*, issued on
12 June 6, 2000, U.S. Patent No. 6,097,966 to Hanley, entitled *WIRELESS ACCESS FOR LOCAL*
13 *EXCHANGE CARRIERS*, issued on August 1, 2000, U.S. Patent No. 6,073,018 to Sallberg,
14 entitled *SYSTEM AND METHOD FOR INTERWORKING OF WIRELESS COMMUNICATION*
15 *SYSTEMS WITH ISDN NETWORKS*, issued on June 6, 2000, U.S. Patent No. 5,506,887 to
16 Emery *et al.*, entitled *PERSONAL COMMUNICATIONS SERVICE USING*
17 *WIRELINE/WIRELESS INTEGRATION*, issued on April 9, 1996, U.S. Patent No. 5,715,296 to
18 Schornack *et al.*, entitled *CONCURRENT WIRELESS/LANDLINE INTERFACE APPARATUS*,
19 issued on February 3, 1998, U.S. Patent No. 5,475,681 to White *et al.*, entitled *WIRELESS IN-*
20 *BUILDING TELECOMMUNICATIONS SYSTEM FOR VOICE AND DATA*

1 *COMMUNICATIONS*, issued on December 12, 1995, U.S. Patent No. 6,049,593 to Acampora,
2 entitled *HYBRID UNIVERSAL BROADBAND TELECOMMUNICATIONS USING SMALL*
3 *RADIO CELLS INTERCONNECTED BY FREE-SPACE OPTICAL LINKS*, issued on April 11,
4 2000, U.S. Patent No. 5,544,226 to Weis *et al.*, entitled *PRIVATE BRANCH EXCHANGE*
5 *HAVING A CENTRAL CONTROL UNIT AND A MOBILE CONTROL UNIT SUBORDINATE*
6 *THERE TO*, issued on August 6, 1996, U.S. Patent No. 5,722,076 to Sakabe *et al.*, entitled
7 *INTRA-PREMISES COMMUNICATION SYSTEM*, issued on February 24, 1998, U.S. Patent No.
8 5,734,699 to Lu *et al.*, entitled *CELLULAR PRIVATE BRANCH EXCHANGES*, issued on March
9 31, 1998, U.S. Patent No. 5,890,064 to Widergen *et al.*, entitled *MOBILE*
10 *TELECOMMUNICATIONS NETWORK HAVING INTEGRATED WIRELESS OFFICE SYSTEM*,
11 issued on March 30, 1999, U.S. Patent No. 5,818,824 to Lu *et al.*, entitled *PRIVATE*
12 *MULTIPLEXING CELLULAR NETWORK*, issued on October 6, 1998, U.S. Patent No.
13 5,953,651 to Lu *et al.*, entitled *CELLULAR ADJUNCT TO A PUBLIC WIRED NETWORK*,
14 issued on September 14, 1999, U.S. Patent No. 5,995,843 to Sjödin *et al.*, entitled *METHOD*
15 *AND ARRANGEMENT FOR USING A MOBILE PHONE IN A WIRELESS OFFICE NETWORK*,
16 issued on November 30, 1999, U.S. Patent No. 5,090,051 to Muppidi *et al.*, entitled *RADIO*
17 *COMMUNICATION SYSTEM AND METHOD FOR CONNECTING AN INCOMING CALL TO*
18 *A WIRELESS TELEPHONE*, issued on February 18, 1992, U.S. Patent No. 5,873,033 to Hjern *et*
19 *al.*, entitled *METHOD AND ARRANGEMENT FOR TRANSFER BETWEEN A CORDLESS*
20 *TELECOMMUNICATION SYSTEM AND A CELLULAR MOBILE TELECOMMUNICATION*
21 *SYSTEM*, issued on February 16, 1999, and U.S. Patent No. 5,898,931 to I'Anson *et al.*, entitled

1 *BASE STATION FOR A TELECOMMUNICATIONS SYSTEM*, issued on April 27, 1999.

2 [0006] In particular, the U.S. Patent No. 5,090,051 discloses a CT-2 phone, which is used as a
3 cordless telephone at home and performs wireless communication for local and international
4 calls through a CT-2 repeater without a handoff. A digital electronic cordless telephone (DECT)
5 communication system, which is a European cordless telephone system, and a cellular GSM
6 communication system, disclosed in U.S. Patent Nos. 5,898,931 and 5,873,033, are connected to
7 the public switched telephone network (PSTN) and provide a communication service to a
8 wireless terminal through a private automatic branch exchange (PABX). These systems are
9 operated and controlled separately from the PABX for the wire in-building communication
10 service and a wireless system for the wireless communication service on the wireless terminal.

11 [0007] Therefore, there has been a demand for a method and system enabling the unified
12 communication service for the wire and wireless in-building data communication and the Internet
13 communication.

14 SUMMARY OF THE INVENTION

15 [0008] It is, therefore, an object of the present invention to provide a unified in-building
16 communication method and system for providing an in-building wireless communication service
17 in a limited local area using a code division multiple access (CDMA) technique and providing
18 various data communication services using the existing wire and Internet protocol (IP) terminals.

1 [0009] It is another object of the present invention to provide a unified in-building
2 communication method and system for providing an economic and reliable unified
3 communication service by combining a CDMA system with voice-over-Internet protocol (VoIP)
4 and gate keeper and commonly using a mobile switching center (MSC) for controlling wire and
5 wireless in-building switching in a private branch exchange (PBX).

6 [0010] It is further another object of the present invention to provide a unified in-building
communication system for providing a wireless in-building communication service in a single-
cell concept, thereby enabling the subscribers to use the service free of charge.

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10 [0011] To achieve the above and other objects, a unified in-building communication system
11 includes an Internet protocol-private branch exchange (IP-PBX), a private base station controller
12 (pBSC), a private base transceiver subsystem (pBTS), a call manager, a router, a local area
network (LAN) switch, and a public land mobile network (PLMN).

13 [0012] The IP-PBX generates a switching control command signal according to an in-building
14 PBX mobile switching call of the mobile terminals, which is set under the control of the call
15 manager connected to the LAN cable, and performs switching according to the generated
16 switching control command signal. Further, the IP-PBX enables an in-building (or extension)
17 call and an incoming/outgoing call through the public switched telephone network/integrated
18 services digital network (PSTN/ISDN), a subscriber line interface (SLI) and a digital line

1 interface (DLI) connected respectively to a wire telephone and a digital telephone for the existing
2 voice communication. In addition, the IP-PBX manages data using maintenance and
3 administration program (MAP), performs message communication on a call message using an
4 information link message, and provides a service between IP terminals with the gateway and gate
5 keeper function using a VoIP by an ITU-T recommendation H.323 interface through the local
6 area network (LAN) cable. The ITU is the International Telecommunications Union, and the
7 ITU-T is the arm of the International Telecommunications Union responsible for
8 telecommunications standards.

9 **[0013]** The pBSC connected to the IP-PBX and a global positioning system (GPS) antenna
10 (GANT), provides a complete path to a mobile subscriber by allocating a vocoder in response to
11 an outgoing call request originated from the mobile terminal, processes an incoming call by
12 allocating a vocoder in response to an incoming call request, processes a test call at the operator's
13 request, and processes a circuit mode data call for G3 facsimile modem and a packet mode data
14 call for Internet service in addition to the voice call. The G3 facsimile modem is a fax connected
15 to a general telephone line. The G3 facsimile modem is a part of a terminal.

16 **[0014]** The private base transceiver subsystem (pBTS) is connected to the private base station
17 controller (pBSC) and divided into a main BTS unit (pMU) and a radio BTS unit (pRU). The
18 pMU performs a high-speed data service in accordance with TIA/EIA/IS-95-B air inter-frequency
19 specification relating to mobile station-base station compatibility standard for dual-mode

1 wideband spread spectrum cellular system. The term TIA represents Telecommunications
2 Industry Association, the term EIA represents Electronics Industries Association, and the term IS
3 represents interim standard. The pMU also performs various handoff power-up functions (PUF),
4 performs closed-loop power control on a reverse link, performs priority access channel
5 designation, performs call processing control on a service in association with a CDMA V.2
6 system, performs operation control for supporting the call processing control function, and
7 performs maintenance, such as state management, test and alert, of the CDMA V.2 system. The
8 pRU connected to the pMU, is connected to repeaters and with the antennas, performs up-
9 conversion on a transmission signal and down-conversion on a receiving signal, and amplifies
10 power of the transmission signal. The "CDMA V.2 system" means a system in a step of the IS-
11 95B prior to being converted into the IS-95C.

12 [0015] The call manager controls the wireless call, performs operation and maintenance on the
13 radio resource, performs PGM and program loaded data (PLD) loading function of a processor
14 for controlling the pBSC resource, controls the wire/wireless unified communication service,
15 supports a wireless in-company short message service (SMS) service, performs visitor location
16 register (VLR) management on a mobile terminal roaming function among an SMS web server,
17 the IP-PBX and the pBSC, and performs registration and function setup on the in-building
18 mobile subscribers. The term "PGM" is an abbreviation for program. This program means a
19 program of a processor with which a call manager controls a wireless call and controls a resource
20 of pBSC and a program for managing a loading function of a PLD.

1 **[0016]** The router connected to the IP network through the E1 line, transmits and receives data
2 at a transfer rate which is a multiple of the T1 or E1-class rate, and accesses a wireless network
3 with the pBSC and an IP-based data network under the control of a telephone network of a circuit
4 switching network with the IP-PBX and the call manager. E1 is a European standard for digital
5 transmission which carries signals at 2.048 megabits per second (Mbps). T1 is a North American
6 standard for digital transmission which carries signals at 1.544 Mbps.

7 **[0017]** The local area network (LAN) switch is connected to the IP-PBX, the pBSC and the
8 call manager through the router, performs a backbone function for switching data in the system
9 and performs a backbone function for allowing the system users to connect with the LAN.

10 **[0018]** The PLMN includes the public mobile switching center (MSC), base station controller
11 (BSC), base transceiver subsystem (BTS), and inter-working function (IWF) connected to the IP
12 network and the private base station controller (pBSC).

13 **[0019]** In accordance with one aspect of the present invention, there is provided a unified in-
14 building communication method in a communication system connected to a PLMN, a
15 PSTN/ISDN, and an IP network. The method comprises setting a common cell area such that a
16 wireless public or wireless in-company communication service is available in a prescribed local
17 area; and connecting a MSC to the PLMN, using a registered mobile terminal as an extension
18 telephone in the common cell area, and bypassing a unregistered mobile terminal, so that the

1 PLMN can share a base station. The unregistered mobile terminal is a terminal that is not
2 registered with the in-building system. In case the unregistered mobile terminal requests a call
3 in-building, the in-building system connects the call to a public switched telephone network.

4 [0020] The registered mobile terminal communicates with a wire extension terminal or a
5 wireless extension terminal, and the registered mobile terminal wirelessly receives a data service
6 through the IP network.

7 [0021] The wireless in-building communication service is performed in a single cell so that a
8 handoff does not occur, and even for the same service provider, when the registered mobile
9 terminal moves out of the common cell and moves into the PLMN and vice versa, the handoff
10 does not occur.

11 [0022] To achieve these and other objects in accordance with the principles of the present
12 invention, as embodied and broadly described, the present invention provides a unified in-
13 building communication method in a communication system connected to a public land mobile
14 network, a public switched telephone network/integrated services digital network, and an Internet
15 protocol network, said method comprising the steps of: forming a common cell area in which a
16 wireless public communication service and a wireless in-building communication service are
17 available in a prescribed local area; connecting a mobile switching center to said public land
18 mobile network; providing communications functions to a registered mobile terminal when said

1 registered mobile terminal is located in said common cell area; and not providing said
2 communications functions to an unregistered mobile terminal, and bypassing said unregistered
3 mobile terminal.

4 **[0023]** To achieve these and other objects in accordance with the principles of the present
5 invention, as embodied and broadly described, the present invention provides a unified in-
6 building communication apparatus connected to a public land mobile network, a public switched
7 telephone network/integrated services digital network, and an Internet protocol network, said
8 apparatus comprising: at least one in-building repeater forming a public/private common cell in
9 which said public land mobile network and an in-building private wireless network are
10 commonly used; a call manager controlling a wireless call of a registered extension mobile
11 terminal of said in-building private wireless network, controlling operation and maintenance of
12 radio resources, controlling private base station controller resources, and controlling registration
13 and function setup of extension mobile subscriber corresponding to said extension mobile
14 terminal; and a public/private communication service unit being connected to said public land
15 mobile network, said public switched telephone network/integrated services digital network, and
16 said Internet protocol network, said public/private communication service unit performing an
17 incoming/outgoing call from and to an office line and an extension call through an in-building
18 private branch exchange, performing wireless communication of a registered mobile terminal in a
19 base station under control of said call manager, and performing communication of an Internet
20 protocol terminal.

1 **[0024]** To achieve these and other objects in accordance with the principles of the present
2 invention, as embodied and broadly described, the present invention provides an apparatus,
3 comprising: at least one in-building repeater forming a public/private common cell in which a
4 public land mobile network and an in-building private wireless network are operating and
5 available; a call manager controlling a wireless call of a registered extension mobile terminal of
6 said in-building private wireless network, controlling operation and maintenance of radio
7 resources, controlling private base station controller resources, and controlling registration and
8 function setup of extension mobile subscriber corresponding to said extension mobile terminal;
9 and a public/private communication service unit being connected to said public land mobile
10 network, a public switched telephone network/integrated services digital network, and an Internet
11 protocol network, said public/private communication service unit performing an
12 incoming/outgoing call from and to an office line and an extension call through an in-building
13 private branch exchange, performing wireless communication of a registered mobile terminal in a
14 base station under control of said call manager, and performing communication of an Internet
15 protocol terminal.

16 **[0025]** The present invention is more specifically described in the following paragraphs by
17 reference to the drawings attached only by way of example. Other advantages and features will
18 become apparent from the following description and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] In the accompanying drawings, which are incorporated in and constitute a part of this specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to exemplify the principles of this invention.

[0027] FIG. 1 is diagram illustrating a network structure for providing various communication services using wire/wireless and Internet protocol (IP) terminals according to an embodiment of the present invention;

[0028] FIG. 2 is a diagram illustrating communication between wireless (or mobile) terminals in a public land mobile network (PLMN), or communication between a wireless local area network (LAN) and the PLMN and the connection between them according to an embodiment of the present invention;

[0029] FIG. 3 is a diagram illustrating the connection among PLMN, public/private common cell, Internet protocol (IP) network, and public switched telephone network/integrated services digital network (PSTN/ISDN) according to an embodiment of the present invention; and

[0030] FIG. 4 is a detailed block diagram of the public/private communication service unit shown in FIG. 3, in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0031] While the present invention will be described more fully hereinafter with reference to the accompanying drawings, in which a preferred embodiment of the present invention is shown,

it is to be understood at the outset of the description which follows that persons of skill in the appropriate arts may modify the invention here described while still achieving the favorable results of this invention. Accordingly, the description which follows is to be understood as being a broad, teaching disclosure directed to persons of skill in the appropriate arts, and not as limiting upon the present invention.

[0032] A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0033] FIG. 1 illustrates a network structure for providing various communication services using wire/wireless and IP terminals according to an embodiment of the present invention. The network structure is comprised of a public land mobile network (PLMN) 141 including mobile switching center (MSC) 302, base station controller (BSC) 306, and home location register/visitor location register (HLR/VLR) 300 for controlling the wireless communication service, and a public-only cell 151 including base transceiver subsystem (BTS) 310 for servicing a mobile subscriber of the PLMN 141 using mobile terminal (MT) 318. Further, the network structure includes a PSTN/ISDN 121 for providing wire voice and data communication services, and a public/private common cell 14, connected to the PLMN 141 and the PSTN/ISDN 121, for providing a wire/wireless unified communication service for both the public and private uses.

1 The public/private common cell 14 includes a public/private communication service unit 100.

2 The public/private common cell 14 defines a particular public/private common communication
3 service area. For example, when a certain company uses (or occupies) one building, an area
4 belonging to the building can be defined as the public/private common cell 14. The
5 public/private common cell 14 is defined by mutual agreement with a public mobile
6 communication service provider. A private BTS (pBTS) 205 in the public/private common cell
7 14 corresponds to the base transceiver subsystem (BTS) from the viewpoint of the PLMN 141.

8 Further, since the public/private communication service unit 100 includes a function of the
9 mobile switching center (MSC) in the PLMN 141, it can provide a communication service
10 between wireless (or mobile) terminals MT1 330 and MTn 332 of the registered service provider
11 in the service area of the public/private common cell 14, as indicated by a dot-dash line (1)
12 shown in FIG. 2. That is, in an exemplary embodiment of the present invention, the
13 public/private communication service unit 100, which serves as a mobile switching center
14 (MSC), is connected to the existing PLMN 141. In this case, the PLMN 141 recognizes the
15 public/private communication service unit 100 as a base station. By doing so, when the
16 registered mobile terminals MT1 330 and MTn 332 make an in-building (or extension) call, a
17 call manager 109 allows the users of the mobile terminals MT1 330 and MTn 332 to use them as
18 an extension telephone set (or interphone).

19 [0034] Otherwise, when an unregistered mobile terminal MT makes an in-building call, the
20 public/private communication service unit 100 bypasses the call. A call made by a registered

mobile terminal MT can be classified into one call made to a wire extension terminal and another call made to a wireless extension terminal. When making a call to the wire extension terminal, a call message is sent to a controller of the public/private communication service unit 100 through a LAN, so that the controller connects a time switch to allow a call to the corresponding terminal, when it is desired to make a call at a certain phone number.

[0035] The unregistered mobile terminal is a terminal that is not registered with the in-building system. In case the unregistered mobile terminal requests a call in-building, the in-building system connects the call to a public switched telephone network.

[0036] The wire extension terminal can be a wire phone, a LAN phone, or a web phone in building. The wire extension phone can correspond to either item 105 or item 111 in FIGS. 3 and 4, for example.

[0037] Since the public/private common cell 14 is formed as a one cell for both the wire/wireless unified in-building communication service and the PLMN 141, the radio wave of the existing PLMN reaches even the building. Therefore, a method for distinguishing the radio wave is required. To this end, a repeater is installed in each floor or a proper place of the building so that the extension (or in-building) mobile terminal MT can acquire the in-building base station. In this case, the pilot strength is controlled to be higher in the building. Therefore, the extension mobile terminal can communicate, free of charge, with other mobile terminals in

1 the PLMN or the building using the private MSC, private BSC and private BTS functions
2 provided by the public/private communication service unit 100.

3 **[0038]** When the mobile terminal moves out of a predefined coverage of the public/private
4 common cell 14 during a call to another extension mobile terminal, the conventional CT-2 phone
5 is not handed-off, whereas the novel mobile terminal of the present invention is handed-off to
6 prevent the user from being charged for the call. In addition, the public/private communication
7 service unit 100 provides a communication service to the PSTN/ISDN 121 and the IP network
8 131, and also provides a communication service to an internal voice terminal or an IP terminal.
9 Further, when the user of the designated voice terminal or the IP terminal is absent, the
10 public/private communication service unit 100 can communicate with a designated mobile
11 terminal MT through the pBTS 205.

12 **[0039]** Meanwhile, the mobile terminal MTn 332 in the public/private common cell 14 can
13 also communicate with a mobile terminal MT 340 of the PLMN 141 as indicated by a dot-dash
14 line (2) shown in FIG. 2, under the control of the public/private communication service unit 100
15 according to the present invention.

16 **[0040]** In FIG. 1, a public switched telephone network/integrated services digital network
17 (PSTN/ISDN) 121 can communicate with a public land mobile network (PLMN) 141 and a
18 public/private communication service unit 100. The PLMN 141 includes a HLR/VLR 300, an

MSC1 302, and a BSCn 306. The MSC1 302 can communicate with MSCn 304, HLR/VLR 300, BSCn 306, and BSC1 308. In addition, the BSC1 308 can communicate with MSC1 302, BTS1 314, and BTSk 312. The BSCn 306 of PLMN 141 can communicate with public only cell 151. The public only cell 151 includes BTS1 310 and mobile terminal MT 318. The public/private common cell 14 includes pBTS 205 and mobile terminal MT 316.

[0041] In FIG. 2, the public/private communication service unit 100 includes private base station controller (pBSC) 201. The pBSC 201 includes switch 322, transcoder and selector bank (TSB) 326, E1 interface 324, and private communication interconnection network (PCIN) 328. As shown in FIG. 2, the PLMN 141 includes MSC 334, BSC 336, and BTS 338. The PLMN 141 can communicate with mobile terminal MT 340. The private base transceiver subsystem (pBTS) 205 can communicate with mobile terminals MT1 330 and MTn 332.

[0042] FIG. 3 illustrates the connection among the PLMN 141, the public/private common cell 14, the public only cell 151, the public/private communication service unit 100, the IP network 131, and the PSTN/ISDN 121 according to an embodiment of the present invention.

[0043] Referring to FIG. 3, the public/private communication service unit 100 installed in a particular area of the building to provide a wire communication service is connected to the PSTN/ISDN 121, the IP network 131, and a wire telephone 111, to process an incoming/outgoing call from and to the office line (i.e., PSTN/ISDN, and private line) and an extension call (of wire,

1 wireless and IP terminals), and service a call from the IP network 131 through the LAN using a
2 LAN phone or web phone 105. Further, the public/private communication service unit 100 can
3 exchange data from the IP network 131 and the PSTN/ISDN 121 with a personal computer (PC)
4 107.

5 **[0044]** In order to receive the wireless communication service according to the present
6 invention, the mobile terminals MT1 354 to MTn 356 controlled by the public/private
7 communication service unit 100 of the public/private common cell 14 should be registered in the
8 communication service provider. Further, an area occupied by the public/private common cell 14
9 includes the private cell defined in the invention and the existing public cell. When it is assumed
10 that the service area of the private cell according to the present invention is limited to a building,
11 the private base transceiver subsystem (pBTS) 205 connected to the public/private
12 communication service unit 100 has antennas ANT1 358 to ANTn 360 installed in each floor of
13 the building through associated repeaters. Installing the repeaters in each floor is intended to
14 increase strength of the pilot signal output from the in-building base station so as to enable the
15 mobile terminals to easily acquire the in-building base station.

16 **[0045]** Therefore, even though the radio wave from the public cell is received, the mobile
17 terminals can distinguish it and provide the service. That is, in the public/private common cell
18 14, the mobile terminal subscribed to a different communication service provider receives a
19 service of a public cell of the existing different base station. Even for the mobile terminal of a

1 subscriber to the same communication service provider, who desires to receive the service in the
2 private cell according to the present invention, if it is not registered, the mobile terminal is
3 controlled by the public/private communication service unit 100. However, it shares only the
4 base station and is bypassed. When the mobile terminal is registered in the same communication
5 service provider for the wireless in-building communication service according to the present
6 invention, it receives the wireless in-building communication service under the control of the call
7 manager 109 of the public/private communication service unit 100. The mobile terminals MT1
8 354 to MTn 356, under the control of the call manager 109 of the public/private communication
9 service unit 100, can receive voice and data services through the LAN phone or web phone 105,
10 a data service through the IP network 131 or the PSTN/ISDN 121, and a data service through the
11 personal computer 107. The call manager 109 controls the public/private communication service
12 unit 100 such that the public/private communication service unit 100 serves as the private MSC
13 and the private BSC. Further, the call manager 109 is connected to the LAN cable to control the
14 overall operation of the system, including management and maintenance of the resources, and
15 registration and function setup of the wireless in-building subscribers.

16 **[0046]** In FIG. 3, the public/private communication service unit 100 includes call manager 109
17 and unit 362. Unit 362 includes pBSC 203 and IP-PBX 201. The units 201 and 203 are more
18 clearly shown in FIG. 4. The PLMN 141 includes HLR/VLR 346, MSC 350, BSC 348, and base
19 station manager (BSM) 352. The public only cell 151 includes mobile terminal MT 342 and
20 BSC 344.

[0047] FIG. 4 illustrates a detailed structure of the public/private communication service unit 100 shown in FIG. 3. Referring to FIG. 4, the public/private communication service unit 100 includes an Internet protocol-private branch exchange (IP-PBX) 201, a private base station controller (pBSC) 203, a private base transceiver subsystem (pBTS) 205, the call manager 109, a router 207, a local area network (LAN) switch 209, and the public land mobile network (PLMN) 141.

[0048] The IP-PBX 201 generates a switching control command signal according to an in-building PBX mobile switching call of the mobile terminals, which is set under the control of the call manager 109 connected to the LAN cable, and performs switching according to the generated switching control command signal. Further, the IP-PBX 201 enables an in-building (or extension) call and an incoming/outgoing call through the PSTN/ISDN 121, a subscriber line interface (SLI) 222 and a digital line interface (DLI) 223 connected respectively to a wire telephone 111 and a digital telephone 105 for the existing voice communication. In addition, the IP-PBX 201 manages data using maintenance and administration program (MAP), performs message communication on a call message using an information link message, and provides a service between Internet protocol (IP) terminals with the gateway and gate keeper function using a voice-over-Internet protocol (VoIP) by an ITU-T recommendation H.323 interface through the local area network (LAN) cable.

[0049] The term "MAP" is a software package of a personal computer for maintenance and

administration of a system. A personal computer having the MAP is connected via a LAN in backplane of a PBX system, and then manages a database within the PBX system in online state.

[0050] The pBSC 203 connected to the IP-PBX 201 and a global positioning system (GPS) antenna (GANT) 364, provides a complete path to a mobile subscriber by allocating a vocoder in response to an outgoing call request originated from the mobile terminal, processes an incoming call by allocating a vocoder in response to an incoming call request, processes a test call at the operator's request, and processes a circuit mode data call for G3 facsimile modem and a packet mode data call for Internet service in addition to the voice call.

[0051] The private base transceiver subsystem (pBTS) 205 is connected to the pBSC 203 and divided into a main BTS unit (pMU) 386 and a radio BTS unit (pRU) 388. The pMU 386 performs a high-speed data service by the IS-95-B air I/F specification, various handoff power-up functions (PUF), closed-loop power control on a reverse link, priority access channel designation, call processing control on a service in association with a CDMA V.2 system, operation control for supporting the call processing control function, and maintenance, such as state management, test and alert, of the CDMA V.2 system.

[0052] The "IS-95B" air interface specification is a service standard of an intermediate step in a process that an IMT-2000 service has developed through an IS-95C. In the present invention, the IS-95B air interface specification corresponds to the standard stipulated in the U.S.

1 Telecommunications Industry Association (TIA).

2 **[0053]** The pRU 388 connected to the pMU 386, is connected to repeaters 261 and 262 with
3 the antennas ANT1 366 to ANTn 368, performs up-conversion on a transmission signal and
4 down-conversion on a receiving signal, and amplifies power of the transmission signal.

5 **[0054]** The call manager 109 controls the wireless call, performs operation and maintenance
6 on the radio resource, performs PGM and program loaded data (PLD) loading function of a
7 processor for controlling the pBSC 203 resource, controls the wire/wireless unified
8 communication service, supports a wireless in-company short message service (SMS), performs
9 visitor location register (VLR) management on a mobile terminal roaming function among a
10 short message service (SMS) web server, the IP-PBX 201 and the pBSC 203, and performs
11 registration and function setup on the in-building mobile subscribers.

12 **[0055]** The router 207 is connected to the IP network 131 through the E1 line and the channel
13 service unit (CSU) 372. The router 207 transmits and receives data at a transfer rate which is a
14 multiple of the T1 or E1-class rate, and accesses a wireless network with the pBSC 203 and an
15 IP-based data network under the control of a telephone network of a circuit switching network
16 with the IP-PBX 201 and the call manager 109.

17 **[0056]** The LAN switch 209 is connected to the IP-PBX 201, the pBSC 203, and the call

manager 109 through the router 207. The LAN switch 209 performs a backbone function for switching data in the system and performs a backbone function for allowing the system users to connect with the LAN. The PLMN 141 includes the public MSC 382, BSC 380, BTS 378, and inter-working function (IWF) 384 connected to the IP network 131 and the pBSC 203.

[0057] The IP-PBX 201 is connected to the PSTN/ISDN 121 through a T1/E1 trunk 221. The wire telephone 111 is connected to the SLI 222, and the digital telephone 105 is connected to the DLI 223. A time switch (T-SW) 224 performs a switching operation under the control of a controller 225, to enable voice communication with the wire telephone 111 and the digital telephone 105, which are the wire terminals.

[0058] The controller 225 is connected to the LAN switch 209 and the call manager 109 through the LAN cable, and performs, when there exists a call for the registered in-building mobile terminal, a switching operation according to a switching control command, thereby performing the MSC function of the existing PLMN. Further, the controller 225 connects the time switch 224 to an Internet trunk module (ITM; or VoIP) 227 such that the wire terminals 111 and 105 interwork with the IP terminal by the time switch 224, thereby servicing the VoIP function. Therefore, the subject of the call becomes the wire, wireless and IP terminals, and call switching for the wire/wireless unified function is performed by the time switch 224 of the IP-PBX 201. The wire/wireless unified function is controlled by the call manager 109. Further, the time switch 224 in the IP-PBX 201 is connected to a transcoder and selector bank interface E1

assembly (TIEA) 231 of the pBSC 203 through an E1 connector 226.

[0059] The pBSC 203 constitutes a private code division multiple access (CDMA) internal connection network. The TIEA 231 in the pBSC 203 is connected to the E1 interface 226 in the IP-PBX 201, and a transcoder and selector bank assembly (TASA) 232. The TASA 232 has the vocoder function for interfacing a 2.048 Mbps non-multiple transmission channel. This is to accommodate 60 vocoders per transcoder and selector bank (TSB) during E1 interfacing, provide an address of a channel element to a vocoder allocated by the call manager 109 during call setup, and provide sign transition and registration information by the mobile terminal to the call manager 109 during the call processing procedure.

[0060] The TIEA 231 detects installation/uninstallation and an operating state of the TASA 232, and provides the corresponding information to the call manager 109. The TIEA 231 and the TASA 232 do not directly provide the entire state information to the call manager 109, but receive the state information through the LAN cable by processing the state information in a high capacity inter-process communication (IPC) node board assembly (HINA) 234 and an Internet protocol network interface assembly (INIA) 233.

[0061] The high capacity inter-process communication node board assembly (HINA) 234 receives a clock at a global positioning system clock receiver (GPSR) 237, and has a processor function, a node address downloading and failure management function and a node blocking and

1 resetting function, while enabling high level data link control (HLDC) packet recognition and
2 processing. The HINA 234 includes PCIN 370. Further, the HINA 234 has a maintenance (M)
3 bus interfacing function for maintaining a high capacity inter-process communication processor
4 assembly (HIPA) 236.

5 **[0062]** The high capacity inter-process communication processor assembly (HIPA) 236
6 provides an inter-process communication channel function for inter-processor communication,
7 and provides maintenance-bus (M-bus) interfacing and data bus (D-bus) interfacing functions for
8 blocking and resetting of a node, and maintenance of the node and link. The Internet protocol
9 network interface assembly (INIA) 233 is connected to the LAN cable to interface with the LAN
10 function, monitors installation/uninstallation and functional failure of the HINA 234 and the
11 HIPA 236, and transmits the monitoring results to the call manager 109 using an Ethernet port.
12 Further, the INIA 233 transmits the packet data received from the mobile terminal to the IP
13 network 131 through the router 207 and the LAN switch 209. A local interface E1 assembly
14 (LIEA) 235 is connected to the HINA 234. The LIEA 235 is connected to the pMU 386 of the
15 pBTS 205 and the PLMN 141 in an E1 line mode, and transmits and receives the packet data in
16 the unchannelized form. The LIEA 235 generates clock, data and alarm from the 2.048 Mbps
17 pulse code modulation (PCM) data received from the other party's office, and assembles 1920
18 Kbps inter-process communication (IPC) data by removing the data required in interfacing with
19 the E1 trunk. The LIEA 235 transmits the generated IPC data to the HINA 234 through a U-link
20 and transmits to the other party's office the IPC data received from the HINA 234 through the U-

1 link at a transfer rate of 2.048 Mbps. The LIEA 235 is connected to a pBTS main controller
2 (PMCC) 241 in the pMU 386 of the pBTS 205.

3 **[0063]** The PMCC 241 in the pMU 386 processes call-setup and system performance-related
4 signaling message, determines transmission power of a call attempted by the mobile station (or
5 mobile terminal), performs management of the entire hardware and software configuration,
6 assigns necessary resources, controls, monitors and manages the entire base station, performs
7 internal packet routing, and interfaces with the pBSC 203.

8 **[0064]** The term "allocation" as used herein refers to allocation of a radio resource (i.e.,
9 frequency, CDMA frame offset, channel element, and code channel) and allocation of an
10 overhead channel (i.e., pilot, synchronization, paging and access channels) to a channel card.
11 The "internal packet routing" interfaces the packet data between the pBSC 203 and a pico BTS
12 channel card (PCC) 243. The PCC 243 processes a channel allocated by the CDMA
13 specification.

14 **[0065]** The CDMA specification can be described as follows. An international IMT-2000
15 technological standardization has mainly been developed into two categories, that is, firstly,
16 based on a North America (CDMA-2000) system and secondly, based on an Europe/Japan (W-
17 CDMA) system. in order to unify these two systems into one, the recent method has been under
18 development based on 3GPP and 3GPP2, but a unified standardization is becoming actually

1 difficult. So far, the technology standardization has been developed by an interest of
2 manufacturing companies such as Ericsson, Lucent Technology, Motorola, and Nokia. However,
3 in the IMT-2000 technology standardization, in order to reflect an opinion of worldwide mobile
4 communication service enterprises, an Operator's Harmonization Group (OHG) was established
5 in May 1999, which proposes a system for unifying a plural standard to ITU, 3GPP and 3GPP2
6 so as to reflect their requests and is associated with the enterprises networks to thereby obtain a
7 self-regulating standard selection right. Also, TTA, ARIB, TTC and TTA were established in
8 January 1999 in order to set a detailed standard, such as a 3rd generation ANSI-41 network,
9 CDMA-2000 and terminal *etc.*, as 3GPP2 (3rd General Partnership Project 2).

10 [0066] The system according to the present invention can include a maximum of 4 PCC
11 boards, and these serve as redundancy during sector operation so as to minimize an influence on
12 the overall capacity even if one of the PCC boards is failed. For processing a baseband signal
13 allocated by the radio specification, each PCC board includes 16 channel elements, and two
14 control digital signal processors (CDSPs) manage 8 channels.

15 [0067] Each PCC 243 transmits pilot channel, sync channel, paging channel and forward
16 traffic channel, performs interleaving, encoding, CDMA direct sequence spreading (DSS),
17 baseband filtering and phase equalization on the forward traffic channel transmitted from the
18 pBSC 203 according to the IS-95-A CAI specification, and performs CDMA demodulation and
19 deinterleaving on the reverse traffic channel received from the mobile station. Further, the PCC

243 supports a polling function between sectors in order to increase its utilization efficiency. That is, the PCC 243 can be allocated to a certain sector through interfacing with the PMCC 241, and allocates the redundant channel element to the overhead channel under the control of the CDSP, when the overhead channel is failed. A transmit/receive interface card (TRIC) 245 is connected to the PCC 243. The TRIC 245 performs transmit/receive interfacing between the pRU 388 of the pBTS 205 and the PCC 243, performs digital conversion and analog processing on the CDMA baseband signal on a transmit/receive path, and provides a CDMA channel distribution matrix between the PCC 243 and the pRU 388 during sector operation.

[0068] The "IS-95-A" CAI (common air interface) specification is a U.S. cellular mobile telephone standard, which is known as "CDMA" in the U.S.

[0069] Further, the TRIC 245 monitors levels and balance of the I and Q signals on the transmission path of the pRU 388, and performs alarm, performance monitoring and fail reporting functions for the PMCC 241, when the monitoring result exceeds a predetermined range. Interfacing with the pRU 388 for the transmit/receive signal in the FA unit combines the I and Q baseband signals on the forward link, and down-converts the received intermediate frequency (IF) signal of 69.99 megahertz (MHz) to a baseband signal. An interfacing according to the transmission/reception of signal between a pMU and pRU in a BTS 205 is performed by TRIC 245 of pMU and XCVU 251 of pRU.

1 [0070] The present invention uses a CDMA method, and the CDMA method uses a QPSK
2 modulated method in order to convert a baseband signal into a high frequency and converts a
3 signal of I-axis and Q-axis into a high frequency having a phase difference of 90 between signals
4 in I-axis and Q-axis by a same oscillator, and then synthesizes two signals. Herein, I-signal is an
5 in-phase channel signal and Q-signal is a quadrature channel signal.

6 [0071] The "FA unit" refers to an RF block of a system, which is a device for performing a
7 wireless connection via a forward link and a reverse link between a CDMA block and a wireless
8 mobile station. The FA unit assigns a wireless resource and manages a state of a radio unit. In
9 the present invention, pRU/pMU correspond to the FA unit.

10 [0072] During the interfacing, interfacing with the PCC 243 receives data input from PCC 243
11 and transmits data output from the PCC 243. Interfacing with the PMCC 241 connects with the
12 PMCC 241 through RS-232 for alarm and failure reporting, monitors levels and balance of the
13 mixed I and Q baseband signals, and reports occurrence of failure, when failure occurs.
14 Interfacing with the pRU 388 duplexes a transmit CDMA I-signal and a main receive interface
15 signal in one coaxial cable, and duplexes a transmit CDMA Q-signal and a diversity receive
16 interface signal in one coaxial cable. RS-232 is an Electronic Industries Association (EIA)
17 standard for asynchronous serial data communications between terminal devices and
18 communications equipment.

[0073] The TRIC 245 in the pMU 386 is connected to a transceiver unit (XCVU) 251 in the pRU 388. The pRU 388 is comprised of the XCVU 251, a pico BTS remote unit controller (PRC) 253 and a cable front-end unit (CFEU) 257. The pRU 388 is connected to the repeaters 261 and 262 with antennas ANT1 366 to ANTn 368.

[0074] Now, the embodiment of the present invention will be described according to its functions. There are three main sections set forth below. First, “wireless in-building communications” is discussed, in accordance with the principles of the present invention. Second, “wireless in-building communication through public land mobile network (PLMN)” is discussed, in accordance with the principles of the present invention. Third, “communication using Internet protocol (IP) terminal” is discussed, in accordance with the principles of the present invention.

[0075] First, “wireless in-building communication” shall be discussed. A wireless in-building communication path is formed along the dot-dash line (1) of FIG. 2. When an incoming call from a mobile terminal, selected from among MT1 330~MTn 332, is received through the repeaters 261 and 262 of FIG. 4, the XCVU 251 receives the call through the CFEU 257. The XCVU 251 is comprised of a transmit/receive synthesizer for generating a local frequency required for an up-conversion block for up-converting the baseband I/Q signal to a desired frequency band signal and a down-conversion block for down-converting the CDMA signal transmitted from the mobile station. The signal passed through the XCVU 251 is applied to the

TRIC 245, and the TRIC 245 performs digital conversion and analog processing on the CDMA baseband during the transmit and receive process between the pRU 388 and the PCC 243. The output of the TRIC 245 is applied to the PCC 243, and the PCC 243 serves as a transmitter for pilot channel #1, sync channel, paging channel and traffic channel in the forward link. Further, the PCC 243 serves as a receiver for access channel and traffic channel on the reverse link. The output of the PCC 243 is applied to the PMCC 241, and the PMCC 241 is connected to the LIEA 235 through the E1 trunk and provides both the signaling and voice data to the LIEA 235 using the unchannelized channel. This data is applied to the HINA 234 through the LIEA 235, and the output of the HINA 234 is provided to the call manager 109. The call manager 109 determines in the visitor location register (VLR) whether the mobile terminal MT1 330~MTn 332 is a registered mobile terminal or not. As stated above, the mobile terminal MT1 330~MTn 332 initiated the incoming call. When the mobile terminal MT1 330~MTn 332 is determined to be an unregistered mobile terminal, the MT1 330~MTn 332 is connected to the PLMN 141. When the mobile terminal MT1 330~MTn 332 is determined to be a registered mobile terminal, then MT1 330~MTn 332 performs an in-building extension call. Only a registered mobile terminal performs an in-building extension call. To perform the wireless in-building (extension) call, a switching function for connection is required, and a voice signal is encoded into pulse code modulation (PCM) signal by Qualcomm code-excited linear prediction (QCELP) and provided to the IP-PBX 201. In order to control the time switch 224, the call manager 109 transmits the signal to the controller 225 through the LAN cable, and the controller 225 connects the switch by controlling the time switch 224. Meanwhile, the voice is converted to pulse code modulation

data through the TASA 232 connected to the TIEA 231, and the pulse code modulation data is converted by the E1 link of the TIEA 231 and provided to the E1 interface 226 in the IP-PBX 201. The global positioning system clock receiver (GPSR) 232 provides the clock to the pBSC 203 and the pBTS 205 using the data received from the satellite. After the switching, as in the incoming path, a call is performed with a different mobile terminal MT via an opposite path.

[0076] Second, “wireless in-building communication through public land mobile network (PLMN)” shall be discussed. A wireless in-building communication path is formed along the dot-dash line (2) of FIG. 2. If the call manager 109 determines that the mobile terminal MT1 330~MTn 332 is an unregistered mobile terminal, signals from that mobile terminal MT1 330~MTn 332 go to the PLMN 141 and pass through the public/private communication service unit 100 as shown in FIG. 2, and are transferred to public/private common cell 14. For the extension call, when the mobile terminal moves out of the public/private common cell 14, a call is dropped (or disconnected) generating an alarm tone. However, for the call made through the PLMN 141, when the mobile terminal moves out of the public/private common cell 14, a handoff occurs through the BSC 336 of the PLMN 141. An incoming call can be received through the PSTN 121 and the PLMN 141. When the incoming call is received through any one of the PSTN 121 and the PLMN 141, the wire and wireless telephones simultaneously generate a ring tone, and its flow is similar to that of the wireless extension call.

[0077] Third, “communication using Internet protocol (IP) terminal” is discussed. The

Internet protocol (IP) terminal receives a communication service through the IP network 131 and the public/private communication service unit 100 under the control of the call manager 109. The IP terminal is connected to the LAN switch 209 included in the system and is connected to another terminal by the call manager 109 after analyzing the IP address. It is also possible to perform incoming and outgoing calls with the existing terminal. If it is desired to make a call to an IP phone in the different area through the wire telephone 111 or the digital phone 105, it is possible to make a call to a desired mobile terminal by the call manager 109 through the ITM 227 in the IP-PBX 201 and the LAN cable.

[0078] As described above, the present invention provides an in-building wireless communication service in a limited local area using a code division multiple access (CDMA) technique and provides various data communication services using the existing wire and IP terminals. Further, the invention provides an economic and reliable unified communication service by combining a CDMA system with voice-over-Internet protocol (VoIP) and gate keeper and commonly using a mobile switching center (MSC) for controlling wire and wireless in-building switching in a private branch exchange (PBX). In addition, the invention provides a wireless in-building communication service in a single-cell concept, thereby enabling the subscribers to use the service free of charge.

[0079] The foregoing paragraphs describe the details of a unified communication system, and in particular, a wire/wireless unified in-building communication method and system, which provides a call service through wire and wireless terminals by connecting a public land mobile

1 network (PLMN) to a local area network (LAN) connected to a public switched telephone
2 network (PSTN), and provides a data service through an Internet protocol (IP) terminal by
3 connecting a local Internet protocol network to the local area network (LAN).

4 **[0080]** While the present invention has been illustrated by the description of embodiments
5 thereof, and while the embodiments have been described in considerable detail, it is not the
6 intention of the applicant to restrict or in any way limit the scope of the appended claims to such
7 detail. Additional advantages and modifications will readily appear to those skilled in the art.
8 Therefore, the invention in its broader aspects is not limited to the specific details, representative
9 apparatus and method, and illustrative examples shown and described. Accordingly, departures
10 may be made from such details without departing from the spirit or scope of the applicant's
11 general inventive concept.